INDICATORS AND METHODS FOR MEASURING TRANSITION TO CLIMATE NEUTRAL CIRCULARITY

Task 5: Case-study group 2

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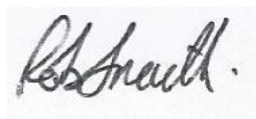T: +44 (0) 1235 753 029
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1. INTRODUCTION

The transition to a circular economy (CE) needs to occur on multiple levels, from households and individual consumers to national and cross-border ecosystems. Measuring and monitoring the development of this transition is an ambitious task and is ideally supported by indicators relevant to all steps in that process.

This case-study is one of 19 developed for a research project into "*Indicators and methods for measuring transition to climate neutral circularity, its benefits, challenges and trade-offs*". It provides a detailed summary of the development and testing programme conducted for Group 2 of the Cities and Regions policy area during Task 5 of the project. The main purpose of this case-study is:

1. Provide an overview of the testing and monitoring method adopted for each indicator.
2. Outline the key results and performance of each indicator.
3. Highlight any challenges or lessons learnt from the identification, planning, delivery and analysis of the relevant methodology for each indicator.

The aim of Task 5 is to take the learnings of all other Tasks thus far and develop and test the new indicators identified in Tasks 3 and 4 as having potential to enable a deeper understanding of the 3 facets of circularity for the five key approaches. This case-study is a direct output of Task 5.

This case-study focuses on the following two indicators outlined in Table 1.

Table 1. Overview of case-study group CR2

URN		Indicator name	Methodology	Level of implementation				
				EU	National	City / Region	Companies	Household
CR6	1	Total quantity of byproducts valorised annually due to regional industrial symbioses systems				X	X	
CR10	2	No. of regional development agencies providing circular economy programmes				X		

2. INDICATOR 1: TOTAL QUANTITY OF BYPRODUCTS VALORISED ANNUALLY DUE TO REGIONAL INDUSTRIAL SYMBIOSES SYSTEMS

This indicator focuses on the total sum of byproducts valorised within industrial symbiosis (IS) systems. The indicator encompasses contractual arrangements where byproducts are exchanged or bought for use in other industrial processes but excludes energy-from-waste (EfW) processing into fuel.

For the purposes of this indicator:

- **Industrial symbiosis** is defined as '*the use by one company or sector of underutilised resources broadly defined (including waste, byproducts, residues, energy, water, [...], with the result of keeping resources in productive use for longer.*' (CEN, 2018). Examples include:

    o waste material for reuse as feedstock to replace raw materials in the manufacturing of new products.

    o water for cooling in production and for process water in industry.

    A **byproduct** is defined as a secondary or incidental product that is produced in the course of making or manufacturing something else. Byproducts often result from industrial processes, chemical reactions, or other activities, and they may have value or utility in their own right, or they may be considered waste or excess material (CEN, 2018). Examples include waste heat, excess steam and organic waste.

EfW was excluded from this indicator as it represents the lowest form of value recovery in the EU Waste Hierarchy[1]. Reliance on waste combustion potentially disincentivises investment in higher value reuse or recycling options, and thus should be viewed as distinct from CE and IS when considering recycling rate improvement and progress towards EU circularity targets.

On 11th March 2020, the EC adopted a new Circular Economy Action Plan (CEAP) which called for facilitating IS by developing an industry-led reporting and certification system[2]. However, progress towards circularity has been slow, with the average rate of circularity of material use in the EU averaging just 11.5% in 2022[3].

Monitoring the total quantity of byproducts valorised annually due to regional IS systems would be beneficial for the EU by providing clear insights into the efficiency and effectiveness of resource utilisation within industrial networks, thereby supporting policy development and strategic planning aimed at achieving EU circularity targets. There are many other benefits to monitoring this indicator, for example:

- It is supportive of the CEAP's objective to reach a circular material use rate of 23.2% by 2030.

- The CEAP recognises IS a key enabler of sustainable consumption and production. This indicator, therefore, provides insights into IS policy effectiveness, further guiding targeted policy development.

- It provides an indication of the effectiveness of regional policies and interventions in enabling IS networks. This insight enables continuous improvement towards circularity targets.

- It can help identify best practices to inform IS guidelines and standards for byproduct valorisation.

- It promotes the efficient use of resources, reducing reliance on virgin materials and the amount of waste sent to landfills or incineration, aligning with higher-value recovery in the EU Waste Hierarchy.

- It encourages innovation in finding new uses for byproducts, enhancing the competitiveness of industries by fostering new technologies and business models.

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[1] EU Waste Framework Directive https://environment.ec.europa.eu/topics/waste-and-recycling/waste-framework-directive_en [Accessed 20 March 2024]

[2] Communication from the Commission to the European Parliament, The Council, The European Economic and Social Committee and the Committee of the Regions: A New Circular Economy Action Plan. COM (2020) 98 final, 2020. https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1583933814386&uri=COM:2020:98:FIN. [Accessed 20 March 2024]

[3] Circular material use rate in Europe, 2024. https://www.eea.europa.eu/en/analysis/indicators/circular-material-use-rate-in-europe [Accessed 20 March 2024]

2.1   KEY METHODOLOGY

2.1.1   Testing method

The system boundary is defined by the valorisation of industrial byproducts within IS systems operating at the municipality, regional and international levels. These have been selected to test the ease of measuring this indicator at three different geographical scales of implementation and context.

- The municipality/city of Kalundborg, Denmark.

    - A well-known and mature IS network often cited as a pioneering example of IS that has been in operation since the 1960s.

- The Scheldt Delta region (SDR):

    - Internationally spanning Zeeland (Netherlands), West-Brabant and East Flanders (Belgium).

    - A relatively mature, cross-border IS collaboration between the industrial sector, the port and government bodies and comprised of large energy and resource-intensive companies.

- The autonomous community of Catalonia (Spain):

    - Comprised of four provinces: Barcelona, Girona, Lleida, and Tarragona.

    - Divided into 947 municipalities.

    - No region-wide IS network but instead consists of smaller-scale partnerships facilitated largely by municipal governments and specialised consultancies.

The indicator was tested by requesting quantifiable data on the volumes of byproducts valorised by IS systems through email correspondence and, followed by a 30-minute semi-structured interview to sense check findings. Organisations were contacted in English or Spanish (for Catalonia) either directly via email where available using MS Outlook or through the contact form found on their website, to request data. An example of the emails sent can be found in Appendix 0.

Due to challenges during testing, a Microsoft Forms survey was created to share with individual companies to allow for a much greater reach and time efficiency, and to partially compensate for lower response rates.

Upon receipt and collation of responses the data were analysed and, where appropriate, developed into composite visualisations. Details of the full survey is available in Appendix 4.3. A Spanish version was provided for stakeholders in Catalonia. The data collection sheet is available in Appendix 4.4.

2.1.2   Data collection method

The data required to measure this indicator were quantities of byproducts valorised within individual IS systems. Comprehensive desk-based research on IS systems in each case study city/region was conducted. A snowball sampling method was used, which involved identifying initial stakeholders with whom Ricardo have previously contacted who could then refer additional potential participants. Snowball sampling is a non-probability sampling method whereby research participants are asked to assist researchers in identifying other potential subjects relevant to the study. While this method does introduce a risk of selection bias, it complements the research by providing access to context specific information that would have otherwise been challenging to identify through desk-based research alone. This method was chosen due to the interdependencies and collaborative nature of IS networks, where members of these networks are assumed to either have direct or indirect relationships with, or knowledge of, CE stakeholders and organisations relevant to this indicator.

Relevant stakeholders included:

- Industry representatives involved in IS systems.

- Regional industry associations promoting IS and/or CE.

- Municipality and local government representatives promoting IS and/or CE.

- Private organisations involved within IS systems.

- Industry associations involved in the promotion of IS and/or CE.

- Sustainability and/or economic development departments within city/regional government.

Following the saturation of available data sources, a pool of identified stakeholders were targeted to request a survey response and/or a conduct a 30-minute semi-structured interview to sense check data. The list of the 50+ organisations contacted was recorded using MS Excel and can be found in Appendix 4.5.

Stakeholders were contacted in Kalundborg (5), Scheldt Delta (46) and Catalonia (38) between January to March 2023. Initially, associations and coordinators of regional IS systems were contacted due to identified efficiencies in engaging with larger stakeholder groups capable of sourcing or requesting data from individual organisations within their IS network. Organisations who did not respond to the initial email were followed up with at least once where feasible.

2.1.3 Calculations

The indicator was assessing by summing the quantity of byproducts (in tonnes) valorised by entities operating industrial symbiosis systems within a city or region.

To enable the aggregation of different byproducts into a single metric, groundwater measured in cubic meters (m^3) was converted to tonnes, using the formula where 1 m^3 of water is equal to 1 tonne. Based on the data collected, no other metric conversions were necessary.

2.1.4 Timeline

Table 2 shows the Gantt chart for the testing timeline.

Table 2 Gantt chart for indicator timeline

w/c	08/01	15/01	22/01	29/01	05/02	12/02	19/02	26/02	04/03	11/03	18/03	25/03
T1 - Build data request form & stakeholder engagement template	■											
T2 - Identify and engage individual stakeholders in relevant IS systems	■	■	■	■	■	■	■					
T3 - Identify and engage individual stakeholders				■			■	■	■	■		
T4 - Data Collection requests				■			■	■	■	■		
T5 - Stakeholder interviews												
T6 - Analysis										■		
Review period											Phase 1	Ricardo
Key deliverables											Case study draft	Final case study

2.1.5   Data gaps and mitigation

Multiple data gaps were observed during the data collection process, especially when assessing the indicator at regional and international scales, with some gaps potentially being not being feasible to mitigate. Gaps include:

- Restricted or incomplete access to data.

- Challenges in data verification as there was no way to audit or verify provided data.

- Lack of disaggregation of byproduct streams and ambiguity in byproduct classification

Table 3 below summarises data gaps and outlines the mitigation strategies applied where feasible.

Table 3. Overview of identified data gaps, limitations and mitigation efforts

Description of data gap	Mitigation efforts	Level of confidence
Unavailable data at the regional/international levels	• Created a short MS Forms survey to share with municipal-level stakeholders for dissemination among organisations within their IS network. • Through further desk research, the individual organisations within clusters or IS projects facilitated by organisations promoting IS (e.g. Simbiosy) were identified and directly contacted them to gather organisational-level data. • Result: Successfully collected more comprehensive data from municipal-level stakeholders and organisations contacted directly, however gaps still remain.	Medium
Restricted or incomplete access to data	• Reached out to relevant stakeholders to request access to additional data or clarify existing data access restrictions. • Alternative sources of data were explored, including publicly available information on websites. • Result: Identified byproduct types valorised by organisations and clarified data access restrictions through stakeholder engagement	Medium
Ambiguities in byproduct classification or lack of disaggregation	• Where feasible, further desk based research was conducted to explore the use of alternative data sources • Engaged with stakeholders to get/provide further clarification by email or discussion call. • Ensured MS Forms survey contained additional info and detailed questions to provide further clarity and structure answers. • Result: improved clarity in responses and understanding of barriers to data disaggregation experienced by stakeholders.	High
Inability to perform data verification	• Using stakeholder-provided data from surveys or interviews may introduce biases, as organizations may underreport or selectively report their activities. • Expert opinions or peer review from colleagues were sought to validate the accuracy and reliability of the provided data.	Low

2.1.6 Quality review of analysis

To ensure robust and high-quality results, the following data validation and quality control procedures were conducted:

- Prior to work beginning, the Project Director reviewed the proposed research methodology and ensured that the data collection plan was fit for purpose. Once the research team had addressed any comments from the review process, they proceeded to the data collection phase.

- The research team built an excel database to record the quantifiable data associated with each industrial symbiosis system, categorised by byproduct/material stream. This was reviewed by the Project Director prior to analysis being conducted.

- The research team presented semi-structured interview guides and a list of stakeholders identified for interview to the Project Director for review prior to interviews being carried out.

- The Quality Assurance Manager held responsibility for the quality of the final case study output. The Project Manager assisted the Quality Assurance Manager in judging the quality of the output and suggesting ways to improve.

2.2 KEY ANALYSIS RESULTS

2.2.1 Analysis

Data collection by stakeholders varied across the studied regions: in Kalundborg and the Scheldt-Delta there was indication that some data is collected though it is unclear if this is standardised within the IS networks; in Catalonia, respondents generally lacked the resources to track data. The regional variation in data availability and collection practices may be influenced by multiple factors such as regulatory environments, time/resource availability, and IS system maturity, highlighting a broader challenge to the standardisation of IS reporting.

The exchange of data differed regionally: while initial emails were responded to, data sharing was limited in Kalundborg due to confidentiality issues; in the Scheldt Delta, responses indicated forwarding of requests but no further data sharing; in Catalonia, varied responses were received, with some unable to track requested data and others providing data via survey or email.

Interpreting the data proved challenging in general, with varied responses across regions: in Kalundborg, data disaggregation was limited, making interpretation of shared data difficult without supplementary desk-research; in the Scheldt Delta, the lack of responses hindered comprehensive understanding; in Catalonia, while some data was provided the varied nature of the stakeholders limited comparability and interpretation against the indicator.

Table 4. Overview of data gathered for indicator CR6

City/region	Total quantity of byproducts valorised annually (tonnes)	Byproducts within quantity valorised	No. of byproduct types identified
Kalundborg	4,192,000	- Residual waste - Groundwater - Waste oil	13
Scheldt-Delta	N/A	N/A	N/A
Catalonia	1,071	- Plastic - Food waste	2

2.2.1.1 The city of Kalundborg

The Kalundborg Symbiosis (KS) cluster consists of 19 organisations, although some do not directly valorise byproducts but instead take on supporting roles (e.g. transporting waste). The representatives of KS responded to the initial email but were unable to share data for individual businesses, therefore analysis could

only be conducted at the cluster-level. In 2019, the KS cluster valorised 62,000 tonnes of aggregated residual material and saved 4 million m³ of groundwater.

Further desk research conducted on the businesses was able to generally disaggregate the material types valorised by members in the system, although this was not always discernible from the information provided on the KS webpage or member web pages. The types of waste streams exchanged in the network varied based on the sectors involved. The byproducts valorised within the cluster were varied, including household waste, waste oil, gypsum, hemicellulose, organic residual material, wastewater, heat, bio natural gas, steam, and biomethane. Data on quantities of byproducts valorised were not found during the desk research analysis, although one oil re-refiner plant in the cluster indicated it has a production capacity of 130,000 tonnes per year on their webpage.

2.2.1.2 The Scheldt Delta region

The Scheldt Delta region was chosen to identify potential cross-border challenges in reporting on IS data. The region hosts competitive, energy-intensive industries, but navigating data confidentiality and global-scale company operations posed challenges in requesting and accessing the requested data. Of the 46 emails initially sent, 9 respondents replied that the request would be forwarded onto the relevant within the organisation, however no further responses were received. Furthermore, while 2 organisations, SDR Netherlands and Kronos, were interested in the study, they were unable to share data due to confidentiality issues or lacked the resource and/or time constraints to coordinate this.

2.2.1.3 The region of Catalonia

Industrial symbiosis plays a vital role in the CE strategy of Catalonia, aligning with their commitment to accelerating the transition towards a circularity, as evidenced by the approval of the Roadmap for the Circular Economy in Catalonia (FRECC) 2030[4]. This emphasises the importance of engaging key industrial symbiosis stakeholders in the region to understand current progress and barriers in measuring circularity.

From the 38 initial emails sent, a total of 11 responses were received. Of these, 4 respondents indicated that the data requested was not tracked, as they work either at the municipal level or helped facilitate IS partnerships but were not involved directly valorise byproducts, and therefore did not track the requested data. Two respondents indicated they do not have the time or resources to prepare the data needed. Two respondents passed on the data request, but no further response was received. Three respondents were able to share data via survey or email correspondence.

The case of Catalonia underscored the vital role of intermediary organisations in facilitating IS initiatives. Acting as a bridge between potential IS partners, they play a crucial role in overcoming barriers to data collection and project implementation, ultimately fostering collaboration and regional CE progress. Simbiosy was identified as a key initial potential contact due to their role in facilitating IS pilot projects and their operation of a data management tool to track material flows across Catalonia. However, due to time and resource challengers, the Symbiosy team were unable to provide the project team with access to the platform data. Organisations engaged in IS with the help of Simbiosy were contacted for data, but few were mature organisations which limited the quality and availability of data:

- GRID Granollers valorised approximately 10 tonnes of plastic film waste in a pilot test.

- Espigoladors shared that a total of 1,061 tonnes of residual food surplus waste were valorised in 2022 across 5 companies in the SIMBIOSIS P(0)MA project, into 1,044 tonnes of animal feed and 17 tonnes of canned vegetables.

Overall, a sum of 1,071 tonnes of byproduct were valorised between the two IS systems.

2.2.2 Limitations

There were a number of limitations to this work:

- No overarching systems were in place to collect data on byproduct valorisation within IS.

- Data from surveys may be selectively or under-reported by stakeholders due to confidentiality concerns, competitive reasons, or differing perceptions of what constitutes byproduct valorisation, introducing potential self-reported biases.

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[4] Full de Ruta de l'Economia Circular a Catalunya (FRECC) 2030, 2024.
https://mediambient.gencat.cat/web/.content/home/actualitat/2024/docs/FRECC_Consell-Tecnic_.pdf [Accessed 20 March 2024]

- While the indicator specifies "annually", annual data was either not available or data could only be provided at a project level where the length of implementation was unclear.

- There is no standardised definitions for of "byproduct" and "valorisation".

  - In an interview with GRID Granollers, stakeholders stated that changes in Spanish waste regulations have made it difficult to report data due to the regulatory definition of "byproduct". In Catalonia, byproduct producer(s) and recipient(s) must apply to the Waste Agency of Catalonia for the authorised use of a byproduct for a specific industrial activity[5]. Due to this, byproducts can be very costly to manage and, where secondary materials or byproducts are used, they may not be classified as such by the organisations using them. As such, it is understood that the availability of data on byproducts more broadly may be limited.

  - The lack of clear definitions can result in inconsistencies in data collection and analysis, limiting the ability to accurately quantify the extent of byproduct valorisation and compare regional indicator performance.

- The presence of a dominant byproduct, like groundwater, can distort final calculated quantity significantly, inflating the indication of regional IS activity.

- It was not possible to obtain data on the quantities of byproduct valorisation from all companies within a cluster, therefore the data collected is not representative of each case study cluster. It is expected that further stakeholder engagement would be needed to obtain this information.

2.2.3   Performance

Table 5 below describes how this indicator performed against the RACER evaluation following testing and compares this against its original RACER assessment. Each element is scored out of three. The cell colours indicate good (green), neutral (amber) or poor (red). The original RACER assessment for this indicator gave a score of 15 out of 15, but following testing this was modified to 11 out of 15, for the reasons below:

- **Relevance**: Testing showed that the indicator was relevant as it can directly measure the practical implementation of CE principles, support progress towards true circularity within regional industrial clusters and incentivise participation in commercial exchanges of byproducts.

- **Acceptability**: The original assessment for this criterion was 3. After testing it was decided to change the score to 2. Key stakeholders generally accept the importance of measuring it due to clear economic and social benefits, but further efforts are needed to alleviate concerns regarding data confidentiality at the level of individual organisations.

- **Credibility**: After testing it was decided to change the score from 3 to 2. There are existing methodologies to measure this indicator, such as tracking the volume of valorised byproducts, however they may vary in complexity and application across different regions and industries. Furthermore, different waste streams may have varying levels of impact and therefore differences in value and credibility for tracking.

- **Ease**: This criterion was changed from 3 to 1 because the metrics are broadly understood but are not readily measured as the data is deemed resource intensive to collect by companies.

- **Robustness**: the original assessment gave a score of 3 for this criterion, which was left unchanged as, where data was available or shared, the indicator can be considered one dimensional.

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[5] Orden TEC/852/2019, de 25 de julio, por la que se determina cuándo los residuos de producción de material polimérico utilizados en la producción de film agrícola para ensilaje, se consideran subproductos con arreglo a la Ley 22/2011, de 28 de julio, de residuos y suelos contaminados, 2019. https://www.boe.es/eli/es/o/2019/07/25/tec852 [Accessed 20 March 2024]

Table 5. RACER evaluation

Stage of project	RACER criterion					Score
	Relevance	Acceptability	Credibility	Ease	Robustness	
Task 4 (original RACER assessment)	3	3	3	3	3	15
After Task 5 (following testing)	3	2	2	1	3	11

2.3 CHALLENGES AND LESSONS LEARNED

2.3.1 Challenges

Several challenges were recorded throughout the process of creating and testing this indicator, including:

- Collecting regional and international-level data. The project approach looked to collect data via representatives of the largest IS clusters or facilitators of IS to allow for comparison on the indicator at different implementation levels, however this was not possible. Representatives advised to contact individual partners however this yielded a low response rate.

- Particularly within more mature IS clusters hosting companies operating in competitive sectors, data confidentiality and navigating global-scale company communication structures posed challenges in requesting and accessing data that may be perceived as commercially sensitive.

- Organisations do not plan to monitor data due to lack of knowledge, perceived lack of benefits of participation, and/or overall time and resource intensity of data collection. Particularly for SMEs, there is a lack of technical capability and time to collect and analyse data.

- Although brief definitions of IS, byproducts and valorisation were shared in the survey set to stakeholders, diverse perspectives on IS and byproducts can create data reporting inconsistencies and hinder establishing EU-wide benchmarks for the metric.

- Some organisations were interested but unable to prepare the requested data but not within the timescale of the study due to temporary unavailability of resources or other priorities.

- Difficulty identifying the suitable contacts with access to requested data. Many organisational web pages offer only general email addresses, resulting in a low response rate.

2.3.2 Lessons Learned

The lessons learned from the challenges encountered above are discussed below, which can be applied to inform future assessments:

- Establishing standardised definitions and reporting protocols for IS activities is crucial to ensure consistent and comparable data collection across regions and industries.

- Greater engagement with IS clusters will be crucial to understand potential barriers and address concerns to facilitate collection of the data required for this indicator.

- Economic incentivisation, technical guidance, support on data collection and reporting may be necessary to support companies in collating data. Specific recommendations are outlined in Table 6.

- Given that desk-research yielded limited quantitative data, it would have been beneficial to prioritise stakeholder engagement first. Furthermore, the survey shared with individual companies, which was created to mitigate initial low responses, would further increase time efficiency in the future if employed from the onset of monitoring.

- Implementing a targeted outreach strategy via professional networking platforms like LinkedIn could improve direct connections with stakeholders. Providing a list of potentially relevant job roles

overseeing circular economy/waste could support effective data request handling. Providing a list of potentially relevant job roles with oversight on CE/waste could further aid those responsible for general inboxes to identify who best to pass the request to.

- Previous Interreg connections and Simbiosy affiliations likely boosted response rates. Future assessments should proactively identify additional contacts, for example through DG-RTD studies (such as a previous DG-RTD review of IS projects[6]) to engage stakeholders earlier in the data collection phase. Establishing robust communication channels with key facilitators of regional IS activities (e.g. SDR and Simbiosy) will be essential for future assessments.

- Existing incentives and benefits of data collection and collaboration should be clearly emphasised during stakeholder engagement.

2.4 CONCLUSIONS AND RECOMMENDATIONS

It is recommended that this indicator *is* considered for further development, with *significant* work required to facilitate its progress.

The testing of this indicator showed that data was not readily available and that stakeholders were not responsive to data collection requests. Nevertheless, it is expected that this indicator is suitable for further development across the EU as it was shown to be suitable for measuring CE progress, and such data is being collected in well-established IS clusters although not accessible while testing this indicator. However, the credibility and robustness of data collected differ regionally due to differences in legislation, the size and nature of businesses within IS clusters and awareness of IS as an approach. Furthermore, changing external factors like market demand, environmental regulations, and global supply chain changes can influence IS viability and effectiveness, potentially affecting metric relevance and applicability.

Given the substantial time and resources required for organisations to gather necessary data, testing this indicator at the regional level may be difficult without additional support. Regional associations and government agencies typically lack the capacity to manage data collation for companies within their jurisdiction, except in the cases of more mature IS systems. Key contacts such as Simbiosy and Smart Delta Resources played a vital role in this study, given their overarching facilitator role within their respective IS networks. Establishing robust communication channels with similar facilitators will be essential for future studies, as such contacts can facilitate direct contact with key personnel responsible for IS operations in companies under IS partnerships.

Adding to this, the legislative barriers around recognising certain materials as a "byproduct" which could result in cross-border inconsistences (as exemplified by byproduct regulations in Spain, while comparable regulations are not present in other case study regions) and introduce challenges to the comparability of data. Some disaggregation of the indicator to allow for separate reporting of different byproduct types would help reduce potential distortions from the aggregation of more common/lower value byproducts, for example water, and factor in regional differences in byproduct classification. Investment towards standardising IS frameworks across member states, and developing dedicated IS support services to conduct life-cycle assessments and material flow analysis could also help enhance data collection efforts and provide a comprehensive understanding of different byproduct valorisation pathways within IS systems.

Another key barrier, particularly for large companies in competitive industries, is that requesting data can potentially be perceived as commercially sensitive for stakeholders, without external partnerships or formal confidentiality agreements in place. Developing confidentiality agreements with clear terms and conditions that specify how data will be used, protected, and shared can provide reassurance to participating organisations. It is recommended to negotiate such agreements with IS associations before approaching individual partners within the IS cluster to improve the chances of data accessibility. Furthermore, incentives for data-sharing should be emphasised, such as access to benchmarking insights which can help companies identify areas for improvement, realise cost-saving opportunities and establishing a competitive advantage.

Considering the existing barriers, adjustments to the indicator, such as testing at local levels or simplifying by measuring the number of businesses implementing IS in a region/cluster, could be explored until

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[6] Study and portfolio review of the projects on industrial symbiosis in DG Research and Innovation: Findings and recommendations https://www.aspire2050.eu/sites/default/files/users/user222/ec_is_portfolio_review_200309.pdf [Accessed 20 March 2024]

methodologies for defining and quantifying byproduct valorisations are developed and standardised across the EU, enabling the expansion of data collection scope and system boundary.

Overall, despite the barriers discussed, stakeholders acknowledged the value of monitoring the volume of materials which are available on their material exchange platform, as well as the number of businesses which participate in IS. Moving forward, this indicator can support the development of future IS projects and enable continuous improvement towards circularity targets.

Given the challenges and insights from testing, the name "Total Quantity of Byproducts Valorised Annually Due to Regional Industrial Symbioses Systems" remains fit for purpose, but could be enhanced to "Total Quantity of Byproducts Valorised Annually Due to Regional Industrial Symbioses Systems and Partnerships" to better reflect the inclusion of smaller scale IS partnerships, such as between SMEs that may not form part of a more mature IS network within a region.

Table 6 below provides a list of suggestions to address/mitigate the identified challenges and improve data collection for the indicator:

Table 6: Summary of recommendations for indicator CR6

Type of recommendation	Recommendation	Timeline	Key stakeholders or partners	RACER criteria addressed
Standardisation of byproduct definitions and categorisations	Standardisation of byproduct types (allowing some level of aggregation of different waste streams) would alleviate data collection pressure and support comparability between MS.	Short (0.5-1.5 years)	Responsible: EC Accountable: EC and National EU governments. Consulted: relevant industry bodies. Informed: relevant IS actors.	Relevance Credibility Ease Robustness
Develop standardised monitoring framework for regional IS networks	Develop guidance to harmonise quantitative reporting of IS, outlining standardised protocols and methodologies for collecting and reporting IS-related data to facilitate consistency and comparability. This should specifically seek to provide guidance on the categorisation and monitoring of industry-specific byproducts.	Medium (1.5 – 5 years)	Responsible: EC Accountable: EC and National EU governments. Consulted: relevant industry bodies and IS clusters. Informed: relevant IS actors.	Relevance Credibility Ease Robustness
Develop legislative and/or policy incentives to facilitate IS-related data sharing	Access to commercially sensitive data is one of the main obstacles faced by cities and regions. The EC should seek to develop legislative or policy incentives to encourage the sharing of data regarding the production and valorisation of byproducts through industrial symbiosis.	Medium (1.5-5 years)	Responsible: EC Accountable: EC, National and regional/local governments	Acceptance
Develop an anonymised IS reporting platform	Shared anonymous data platform/tool for IS clusters or regional authorities to report on quantities of byproduct valorisation. Could be further supported by legislation to incentivise reporting and use of the tool.	Medium (1.5 – 5 years)	Responsible: EC Accountable: EC. Consulted: Local municipalities and regional authorities Informed: relevant IS actors	Relevance Acceptance Credibility Robustness

Type of recommendation	Recommendation	Timeline	Key stakeholders or partners	RACER criteria addressed
Facilitate engagement platforms for IS practitioners	Arrange regular engagement events, for example conferences and workshops for IS practitioners to: • Facilitate knowledge sharing. • Foster IS partnerships and collaboration.	Medium (1.5 – 5 years)	Responsible: EC Accountable: EC and National EU governments. Consulted: relevant industry bodies. Informed: businesses implementing/interested in IS.	Relevance Acceptance Credibility

3. INDICATOR 2: NUMBER OF REGIONAL DEVELOPMENT AGENCIES PROVIDING CIRCULAR ECONOMY PROGRAMMES

This indicator seeks to measure the number of regional development agencies offering circular economy (CE) support programmes, which are defined as programmes designed to build regional CE capabilities, and includes: training, knowledge-building, research and innovation, funding, and business support programmes dedicated towards the implementation of CE principles and strategies within both the public and private sectors.

For the purposes of this indicator, a development agency is an organisation that plays a pivotal role in enhancing the economic well-being within a specific area. It works in partnerships with public authorities, private sector organisations and community groups to promote sustainable economic development. Although these agencies have historically been public sector entities, they increasingly include and collaborate with private sector organisations that support and advance public economic policies, particularly for initiatives focused on the CE. To deliver these services, development agencies do not necessarily need to be standalone organisations but can be embedded within larger organisations or public institutions.

This directly contributes to the objectives of the Circular Economy Action Plan (CEAP), which specifically refers to the need to improve awareness-raising, cooperation, and capacity-building to facilitate the transition to a circular economy across cities and regions. Within this context, it is expected that 'Cohesion Policy funds will help regions to implement CE strategies and reinforce their industrial fabric and value chains' (EU Commission, 2020). While initiatives such as the European Urban Initiative,[7] the Intelligent Cities Challenge Initiative,[8] and the Circular Cities and Regions Initiative[9] will provide key assistance to cities in tailoring the application of these circular strategies for their regional contexts, there is a need to monitor whether and how these are being implemented at the local and regional level.

As development agencies will likely be conduits for implementing these schemes, monitoring this indicator will provide an easily quantifiable metric to understand the extent to which circular support programmes are available to local business and entrepreneurial networks.

There are several benefits to monitoring this indicator, for example:

- It enables the EU to effectively monitor the distribution of CE activity networks. This provides an easily quantifiable metric to understand and compare the extent to which circular support programmes are available to local business and entrepreneurs across regions.

- It indicates the success of local and regional administrative bodies in establishing or supporting bottom-up CE initiatives that directly contribute to local economies.

- It incentivises the promotion of circular innovation and business support programmes. In so doing, local administrations can contribute to the enabling conditions for a just and sustainable transition among local business communities.

- It provides a proxy to measure the effectiveness of CEAP's Cohesion Funds, which aim to help regions to implement CE strategies and reinforce their industrial fabric and value chains.

- Access to CE capability-building programmes support the CCRI's core aims, enabling cities to tailor the application of CE strategies to regional contexts.

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[7] European Urban Initiative, What is the European Urban Initiative?. (European Urban Initiative, 2024). https://www.urban-initiative.eu/what-european-urban-initiative. Accessed: 16/04/2024.

[8] Intelligent Cities Challenge, About ICC. (The European Commission's Intelligent Cities Challenge, 2024). https://www.intelligentcitieschallenge.eu/about-icc. Accessed: 16/04/2024.

[9] European Commission, Circular Cities and Regions Initiative. (Circular Cities and Regions, 2024). https://circular-cities-and-regions.ec.europa.eu/about. Accessed: 16/04/2024

3.1 KEY METHODOLOGY

3.1.1 Testing method

The geographical scope of the system boundary will refer to the legal boundary of two cities and one region in the EU to test the different contexts that may influence the monitoring of this indicator. These are:

- The City of Prague (Czech Republic).
- The City of Rotterdam (the Netherlands).
- The Government of Navarra (Spain).

The city of Rotterdam was selected due to the work of the Municipality developing policies to enable the transition to a circular economy. A member of the C40 Cities network, they are a signatory of the Advancing Towards Zero Waste Declaration,[10] and have set ambitious targets in their Rotterdam Circularity programme 2019-2023 to halve material consumption by 2030 and become fully circular by 2050 (Rotterdam Circulair, 2019). Aligned with these aims, the Municipality has actively developed CE innovation and entrepreneurship programmes to support the growth of circular SMEs. Similarly, the city of Prague was selected due to recent work in the development and implementation of the Circular Prague 2030: Prague Strategy for Transition to a Circular Economy, approved in 2022 (Prague Innovation Institute, 2022). This strategy contains objectives to provide subsidies for CE innovation, and improve the competitiveness and internationalisation of the entrepreneurial sector. These two case studies allowed the research team to test how this indicator can be monitored at the municipal level.

The autonomous region of Navarra (Spain) was selected as the regional government has been working on the development of circular economy policies since 2007. A transition to a CE has been adopted as a core strategic priority within their Specialisation Strategy for Sustainability (S4) (Gobierno de Navarra, 2022), and Navarra's Industrialisation Plan 2021-2025 (Gobierno de Navarra, 2022) to address challenges characteristic of rural communities within the EU, namely rural depopulation and an ageing population. As such, the way in which CE programmes have been adopted to address these challenges provide a point of comparison to the other two city-based case studies.

Within this geographical scope, this indicator will seek to measure the number of regional development agencies (including private, public-private, and public organisations) actively providing CE programmes and capacity building activities, such as: business support programmes, research and innovation programmes, industry workshops, training and financial support, that are explicitly aligned with CE outcomes.

Traditionally development agencies have been understood as primarily 'neutral player[s] in a region and have no profit motive' (Netherlands Chamber of Commerce, KVK, 2024) that are 'significantly linked with a local, metropolitan or regional authority with respect to management, financing or missions', and are guided by 'mission of economic development characterized by the search of the collective or overall interest of a geographical area' (EURADA, 2016). However, it is also recognised that over time development agencies have shifted from being primarily state-led initiatives, delivering development interventions through 'market-led bodies and business-led approaches (brokerage, marketing, joint ventures, incentives, capitalisation, competitive recruitment, etc)' to delivering support through 'corporate rather than […] municipal, structure[s]' (Mountford, 2009).

Considering the nuanced and evolving ways in which publicly oriented agencies and private, profit-focused entities are working to accelerate regional transitions towards a CE, these definitions could be seen as relatively limited and that there is a need to expand the scope of development agencies.

For the purposes of this study, therefore, the following definition was developed:

- *A development agency is an organisation that plays a pivotal role in enhancing the economic well-being within a specific area. It works in partnerships with public authorities, private sector organisations and community groups to promote sustainable economic development. Although these agencies have historically been public sector entities, they increasingly include, and collaborate with, private sector organisations that support and advance public economic policies, particularly for initiatives focused on the circular economy.*

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[10] C40 Cities, Towards Zero Waste Accelerator. (C40 Cities, 2024). https://www.c40.org/accelerators/zero-waste/. Accessed: 16/04/2024.

This will include nationally focused development agencies within the legal boundaries of the city or region under study.

This will exclude thinktanks that do not provide CE support programmes or capacity building within local public or private organisations.

As the indicator is measuring discrete data points (e.g. whether an entity constitutes a development agency, whether it operates within a specific region, and whether these align with CE outcomes), the testing method will involve desk-based research, combined with stakeholder engagement to assess whether the entities identified during research meet the criteria of a regional development agency.

3.1.2   Data collection method

The data collection process was split into two phases: desk-based research to identify development agencies offering CE programmes, followed by stakeholder engagement activities to verify and augment the findings with either further additions or qualitative, contextual data.

The initial web-based research was conducted in English and the official language of the city/region of study to identify regional development agencies providing CE programmes. Each identified regional development agency was assessed according to the capabilities they were developing (e.g. training, knowledge-building, research and innovation, funding, and business support programmes), and how recent the support provided is.

- Initial search terms used were as follows:
  - ("circular economy" OR "bioeconomy") AND ("development agency" OR "centre" OR "programme") AND ("support" OR "programme" OR "business support" OR "training") AND ("CITY NAME" OR "REGION NAME")

It is recognised that local and regional administrations have developed activity and support networks to allow local stakeholders to embed circular practices within local organisations. These networks facilitate knowledge-sharing on CE topics relevant to each city and/or region's specific context, including regional best practice, policies, funding and business support that may be available. It is therefore assumed that members of these networks will either have direct or indirect relationships with, or knowledge of, CE stakeholders and organisations relevant to this indicator. As such, a snowball sampling method was deployed to improve the efficiency with which interview participants and data were identified. Snowball sampling is a non-probability sampling method whereby research participants are asked to assist researchers in identifying other potential subjects relevant to the study. While this method does introduce a risk of selection bias, it complements the research by providing access to context specific information that would have otherwise been challenging to identify through desk-based research alone.

Once the research team had explored all available data sources, the team contacted relevant municipality/regional CE representatives to sense check their findings. Due to the expected time delay in receiving feedback from these contacted representatives, these stakeholders were contacted at the start of the research process to gauge interest and capacity to participate in the research.

3.1.3   Calculations

Quantitative aggregation of the number of development agencies that meet the criteria of i) residing within the legal boundaries of the cities and regions under included within the research, ii) offering a CE programme, were be used to quantify this indicator.

3.1.4   Timeline

The Gantt chart below illustrates the key stages in the monitoring of this indicator, highlighting what happened and when. In January, the research team carried out desk-based research in each of the three cities and regions to identify the development agencies offering CE programmes. The week commencing January 22nd, the research team proceeded to the stakeholder engagement phase to sense check findings.

Table 7: Gantt chart of activities to test indicator

W/C	18-Dec	25-Dec	01-Jan	08-Jan	15-Jan	22-Jan	29-Jan	05-Feb	12-Feb	19-Feb	26-Feb	04-Mar	11-Mar	18-Mar	25-Mar	01-Apr
Task 1 - Excel model to record development agencies	▒	▓														
Task 2 – Research Rotterdam		▓		▒	▒								▒			
Task 3 – Research Prague		▓			▒	▒										
Task 4 – Research Navarra		▓		▒	▒	▒						▒				
Task 5 – Stakeholder engagement		▓				▒	▒	▒	▒	▒	▒	▒				
Task 6 - Write up findings		▓														
Review period			■						■			■			■	
Key deliverables													▮		▮	

3.1.5 Data gaps and mitigation

Prior to research beginning, it was understood that data relevant to this indicator may be openly available in public repositories, however, how this is stored may vary depending on city or region selected for study.

In addition, it was also understood that language barriers and limited prior knowledge of a region's local context, may present a challenge to the research team in conducting a comprehensive review of a city/region's development agencies, and identifying whether they had reached saturation point.

To mitigate the risk of either over-looking potential data sources, or mischaracterising the services provided by certain development agencies, the research team launched a six-week stakeholder engagement phase with the aim of conducting 45-minute interviews stakeholder engagement interviews with key stakeholders within the identified city/region's CE administrative team.

This led to two interviews with key stakeholders of the respective cities and regions: one 45-minute interview with representatives of the Government of Navarra and Gestión Ambiental de Navarra – Nafarroako Ingurumen Kudeaketa (GAN-NIK),[11] on 5th March 2004, and one 45-minute interview with a CE representative of the Municipality of Rotterdam on 11th March 2024.

Following each interview, the researchers engaged in email correspondence to clarify further questions and verify whether the development agencies identified during the desk-based research were accurate and relevant to the indicator being measured. Several attempts were made to contact relevant members of the City of Prague, without success.

The purpose of these interviews was to:

- Sense-check and validate the findings from desk-based research.
- Understand whether this indicator was already being measured.
- To gain insight into the challenges and benefits of measuring this indicator at the city/regional level.

By engaging with regional and municipality stakeholders involved in the development and/or monitoring of CE policies of the Government of Navarra, and City of Rotterdam, not only was the research team able to verify

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[11] GAN-NIK, Quienes somos. (GAN-NIK – Gestión Ambiental de Navarra, 2024). https://www.gan-nik.es/es#quienes. Accessed: 16/04/2024.

findings from the desk-based research in a time efficient manner, but crucial insights were gained into the feasibility of reporting on this indicator, thereby enhancing the quality of the analysis derived from this research.

This engagement was supplemented by a review of the following platforms to identify additional sources of information:

- Interreg Europe: They support regional development plans, including CE programmes. As such, may be able to provide data on development agencies that meet this indicator's criteria.[12]
- Eionet Portal: This contains country profiles on CE in Europe and as such represents a good resource to understand CE programmes in these countries.[13]

While providing useful information, these two platforms did not provide any additional details that were not previously identified through desk-based research or stakeholder engagement.

Table 8. Overview of identified data gaps, limitations, and mitigation efforts

	Description of data gap	Mitigation efforts	Level of confidence
1	No centralised database of development agencies within each target region.	- Comprehensive desk-based research (method described above) - Stakeholder engagement with key members of each city/region's administrative CE team to validate findings.	High
2	Inconsistency in level of detail available regarding the quality and comprehensiveness of CE programmes on offer.	Stakeholder engagement with city/region's administrative CE team to validate findings and provide additional details.	Medium

3.1.6 Quality review of analysis

To ensure robust and high-quality results, Ricardo conducted the following data validation and quality control procedures:

- Prior to work beginning, the Project Director reviewed the proposed research methodology and ensured that the data collection plan is fit for purpose. Once the research team had addressed any comments from the review process, they were able to proceed to the data collection phase.

- The research team presented semi-structured interview guides and a list of stakeholders identified for interview to the Project Director for review prior to interviews being carried out.

- The Project Director was responsible for reviewing the overall quality of the output of the case studies. The Project Manager assisted the Project Director in judging the quality of the output and suggesting ways to improve before final submission.

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[12] Interreg, List of Programmes and Regions. (Interreg, 2024). https://interreg.eu/list-of-programmes/. Accessed: 16/04/2024.

[13] Bart Ullstein, et al., Country profiles on Circular Economy in Europe. (Eionet Portal, December 2022). https://www.eionet.europa.eu/etcs/etc-ce/products/etc-ce-reports-2022-5-circular-economy-country-profiles-a-set-of-30-country-profiles-that-summarise-policies-and-initiatives-in-the-area-of-circular-economy. Accessed: 16/24/2024.

3.2 KEY ANALYSIS RESULTS

3.2.1 Analysis

As a result of the research, the research team were able to identify a series of development agencies providing CE programmes along the following themes: business support, R&D, professional training, industry workshops and knowledge building, and financial support. These results are summarised in the table below.

Table 9: Results of indicator testing

No of regional development agencies providing Circular Economy programmes			
	Region of Navarra	**City of Rotterdam**	**City of Prague**
Regional development agencies	8	1	2
Industry Associations	2	0	0
Public Companies	2	0	0
Incubators and Entrepreneurship programmes	0	3	0
NGOs	0	0	1
Total	**12**	**4**	**2**

Feedback from the stakeholders interviewed indicated this is a valuable data point that can be easily quantified to provide a partial illustration of the availability of CE support at the local level. Stakeholders interviewed considered monitoring this data to be important as development agencies are in direct contact with the territory and provide them with information on territorial and sectorial needs that can be addressed by relevant government bodies. However, it was also recognised that this indicator should be used in combination with other indicators, such as the public commitment of organisations to regional transition policies and/material consumption rates, in order to provide a more complete understanding of a city or region's transition to a CE.

A further issue, highlighted during stakeholder interviews and desk-based research was the risk of inconsistency in the quality of support being provided due to a lack of standardisation, both within and between the systems studied during this research. Especially at the local level, the robustness of the support programmes offered may vary, and will largely be dependent on the influence and capability of the individuals coordinating action within the development agencies themselves.

In the case of the Region of Navarra, the role of development agencies is directly linked to the regional Smart Specialisation Strategy for Sustainability (S4), which seeks a "just transition" towards a sustainable and inclusive growth model by concentrating resources in economic areas in which each region of Navarra has significant competitive advantages (Gobierno de Navarra, 2022). This is in part designed to address the regional challenges Navarra faces in terms of rural depopulation, "brain drain," in which qualified young people leave the region in search of employment and higher salaries – especially in the areas of knowledge and scientific research, and an ageing population. Within this context, a key policy focus is the promotion of Local Action Groups (public-private associations) will elaborate and execute a development strategy for their region. This is supported by Navarra's Industrialisation Plan 2021-2025, which has a core objective of strengthening industrial competitiveness through the promotion of CE and industrial symbiosis practices (Gobierno de Navarra, 2022). This decentralised approach results in several Local Action Groups being responsible for development of CE support programmes for local businesses within their area. In addition, it was found that the *Asociación de Industria Navarra* (AIN)[14] and *La Asociación de Empresas de la Zona Media de Navarra* (AEZMNA),[15] while industry associations, also worked hand in hand with regional municipalities to provide CE

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[14] AIN, Sobre AIN. (AIN, 2024). https://www.ain.es/quienes-somos/. Accessed: 16/04/2024.
[15] AEZMNA, Diagnóstico y Plan de Activación. (AEZMNA, 2024). https://www.aezmna.com/index.php?m=plan-activacion&subm=diagnostico-y-plan. Accessed: 18/04/2024.

support programmes in alignment with the regional CE strategies of the Government of Navarra, hence their inclusion. These results reflect the way in which CE initiatives seem to be integrated within broader regional economic and social strategies. This integration is critical in ensuring that CE initiatives align with and support broader regional goals in a coherent manner.

In the case of the City of Rotterdam, there were fewer development agencies identified providing CE programmes. This can be partly explained by the high density and interconnectivity of the Netherlands, in which development agencies, research institutes and industrial parks are distributed across several municipality boundaries – thereby blurring the system boundary, which has been set at the city-limits of Rotterdam. For example, the Municipalities of Delft and Wageningen lie to either side of Rotterdam, and both offer research and innovation centres, and incubators that offer CE programmes designed to facilitate the implementation of CE principles into business practice, and by extension accelerate the CE transition. Meanwhile, in the Hague, the Netherlands Enterprise Agency (RVO), part of the Dutch Ministry of Economic Affairs and Climate Policy provides a national business support and subsidy programmes to sustainable and circular businesses across the Netherlands and abroad.[16] This is supported by the national Circular Netherlands Accelerator! which similarly helps individual entrepreneurs by providing answers to questions about knowledge, networks, funding, and legislation, and promotes collaboration between entrepreneurs in circular value chains.[17]

Of particular note, is the BlueCity incubator. While an explicitly private for-profit enterprise, BlueCity has become a key node within the city's circular innovation network and is closely integrated into the municipality's CE strategy.[18] As such, it deviates from the conventional, public-sector/non-profit development agency model, and raises questions about the evolving landscape of economic development support, where public-private partnerships and the integration of CE principles are increasingly common.

In the case of the City of Prague there were also fewer identified development agencies that conformed to the indicator criteria. Again, this can be partially explained by a lack of need/saturation of services providing CE programmes, as well as the relative novel-ness of the CE as an approach to economic development, first launched in 2022 through the Prague 2030 Circular Economy Roadmap (Prague Innovation Institute, 2022). Within this strategy there are several specific objectives to provide support for SMEs and innovation projects to implement circular activities, which are being facilitated by the city-led Circular Prague Platform and Business and Innovation Centre of Prague, thereby obfuscating the need for additional development agencies to provide these services.

These results highlight the relative challenge of comparing the distribution of development agencies at the city level, when capabilities are increasingly distributed at the regional level. In addition, this indicator should be supplemented by further indicators to illustrate the number of professionals receiving training, number of businesses being supported, and the total value of financial support being provided by these programmes to local businesses. Finally, it was found that a more nuanced definition of development agency should be developed by the EU.

3.2.2   Limitations

Scope of study

In the case of the City of Rotterdam, the geographic boundaries posed a challenge in identifying and categorising development agencies that resided within the city's legal boundaries. As discussed in 3.2.1, this may have implications for how programmes are monitored and evaluated. Given the realities of urban and regional interconnections in CE programme implementation, these findings suggest a need to expand the scope of assessment to the regional level. In addition, this approach does not reflect the economic or demographic realities of the cities and regions under analysis.

For example, the region of Navarra, for example is a geographically diverse rural region with a population of 672,155 and a population density of 64.96/km^2, [19] whereas the City of Rotterdam is a major urban centre with

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[16] RVO, Netherlands Enterprise Agency. (RVO, 2024). https://english.rvo.nl/. Accessed: 16/04/2024.

[17] Vernesllignshuis Nederland Circulair!, Over ons. (Vernesllignshuis Nederland Circulair, 2024). https://versnellingshuisce.nl/over-ons. Accessed: 16/04/2024.

[18] BlueCity, Over BlueCity. (BlueCity, 2024). https://www.bluecity.nl/over-bluecity. Accessed: 16/04/2024.

[19] City Population, Navarra. (City Population, 2024). https://www.citypopulation.de/en/spain/admin/NAV__navarra/. Accessed: 16/04/2024.

a population of 671,125 and a population density of 3,085/km^2.[20] As a result, it may be expected that the region of Navarra may have a higher frequency of smaller scale programmes to provide entrepreneurs operating within the municipalities of the region with access to CE support, whereas, in the case of Rotterdam, a smaller number of high impact programmes might be able to provide CE support to a larger number of entrepreneurs clustered within the city centre.

During the stakeholder engagement process, there was some discussion on whether a focus on publicly funded development agencies would be entirely appropriate, given the broad range of stakeholders and other similar, but statutorily distinct, organisations that also provide these CE programme services. This is particularly prevalent in the case of Rotterdam, where private and semi-private start-up incubators and accelerators provide specialist support to entrepreneurs seeking to implement CE business models. Therefore, there is possibility that the results generated through the desk-based research process may be limited.

A further limitation in the study relates to the quality of the circular economy programmes that were identified. The findings presented do not take into account the effectiveness of the scale of the impact of the agencies that provide these services. During the data collection phase, it was found that relatively few of the development agencies identified made public the number of businesses supported, the number of recipients who had received CE training and skills development, or the number of CE projects funded. Consequently, regions with fewer, yet highly impactful agencies may be undervalued, while those with numerous agencies having minimal impacts might appear more influential than they actually are.

Stakeholder engagement

During the desk-based research stage, due to the number of development agencies identified, it was considered not feasible to engage stakeholders from these agencies, or recipients of their support, during the data collection period. Even so, it is acknowledged that this would have allowed for a more comprehensive assessment of the types of services being provided. As such, future research may seek to factor in a longer lead in time for stakeholder engagement, as well as develop tighter conforming criteria that would allow for more robust comparison and discrimination of the programmes provided both within and between regions at the local and European level.

During the stakeholder engagement phase, the research team received no response from representatives of the City of Prague. As such, there is some uncertainty over whether the results emanating from this case study are accurate, or complete.

Language barriers

In addition, there were uncertainties due to language barriers presented during research of the Rotterdam and Prague case studies. While the research team used translation software to translate key terms used in the search for relevant organisations within the target cities and regions, this was a time-consuming process, and this software may miss nuances in language. As such, while the research team did seek to mitigate these barriers by investing more time into identifying relevant development agencies, these results may not be complete.

3.2.3 Performance

Table 10 compares the RACER score allocated to the original indicator during Task 4 against the final indicator after the Task 5 testing process. During Task 4, the original indicator was allocated a score of 11 against the RACER evaluation process, following testing this has been downgraded to a 13. In summary:

- **Relevance:** This refers to whether the indicator is closely linked to EC Circular Economy objectives. Following testing, it has been scored a Good (3), as it was found to be fully aligned with European policy objectives and supports wider systemic change.
- **Acceptability:** This refers to whether the indicator is perceived to be useful and is used by key stakeholders, such as policymakers and industry actors. This was downgraded to Neutral (2), due to some concerns related to the value this would provide to the monitoring of the circular transition due to potential discrepancies in the quality of the support programmes being provided and how this could support current policy efforts in each area. Nonetheless, the stakeholders contacted viewed clear

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[20] City Population, Rotterdam. (City Population, 2024). https://www.citypopulation.de/en/netherlands/admin/zuid_holland/0599__rotterdam/. Accessed: 16/04/2024.

benefits in monitoring the number of organisations providing these CE support programmes given the clear link to regional objectives towards sustainable development.

- **Credibility:** This refers to whether the indicator is transparent, trustworthy and is easy to interpret. This rating was also downgraded to Neutral (2), as this data point is currently not being monitored in a centralised manner and there are regional differences in how each city/region defines the remit of a development agency. In addition, questions remain regarding whether the indicator should monitor solely "regional development agencies" or whether the scope should be expanded to cover other types of organisations or agencies delivering the same services.
- **Ease:** This refers to the easiness of measuring and monitoring the indicator. This was scored as a Good (3), as the data was readily available and the cost of data collection was considered to be low.
- **Robustness:** This refers to whether data is biased and comprehensively assesses circularity. This was scored as Good (3), as a consistent methodology and dataset are available and that this represents a one dimensional indicator (e.g. entities providing CE support programmes).

Table 10. RACER evaluation

Stage of project	RACER criterion					Score
	Relevance	Acceptability	Credibility	Ease	Robustness	
Task 4 (original RACER assessment)	3	3	3	3	3	15
After Task 5 (following testing)	3	2	2	3	3	13

3.3 CHALLENGES AND LESSONS LEARNED

3.3.1 Challenges

Definition of terms

During the testing phase, a key challenge faced was in the classification of terms in relation to development agency. Traditionally, these have been defined as:

> [A]n entity that carries out a territorial development mission characterised by the search of the collective or overall interest of a specific area (and not corporative or sectorial), and that is significantly linked with a local, metropolitan or regional authority with respect to management, financing or missions. A Development Agency is a designated public meeting place and/or orchestrator of local stakeholders with a dynamic structure oriented to support the innovation ecosystems. (EURADA, 2016)

At the same time, however, it is important to acknowledge the increasing role of public-private partnerships in economic development and the contribution of private entities to contribute to a city or region's CE strategies. This could mean broadening the definition to encompass organisations that, despite profit motives, align closely with public CE policies and serve more widespread, public-oriented goals – hence the definition used as set out in Section 3.1.1.

As noted in Section 3.2.1, the evolving nature of development agencies led to some discussion during the stakeholder engagement phase about the acceptability of assessing development agencies as purely public sector or quasi-governmental organisations. While the expanded definition set out in Section 3.1.1 was broadly accepted by the regional and municipality bodies contacted during the testing phase, future monitoring efforts would benefit from established guidance on the key characteristics of development agencies at the EU level.

Criteria of assessment

As noted in Sections 3.2.1 and 3.2.2, it was not possible to conduct more granular analysis of the level of support provided by each regional development agency through their CE support programmes. While this information was sought during the data collection phase, this was often not publicly accessible.

3.3.2 Lessons learned

Criteria of assessment

A key lesson learned is the need for a clear, universally accepted definition of regional development agencies and CE support programme criteria is needed to ensure consistency and comparability of data. As discussed in Sections 3.2.1 and 3.2.2, while it is possible to compare the number of CE support programmes that are being provided by regional development agencies, this indicator does not facilitate analysis of their quality or impact. It is recommended that future development of this indicator includes criteria for assessing the number of businesses supported, the number of recipients receiving CE training, and the value of financial support provided to CE initiatives. This more granular level of detail will enable policymakers to make more accurate, context-specific assessments of the level of CE support provided within each city and region.

Stakeholder engagement

To ensure that the research team was able to test the feasibility of monitoring this indicator across EU Cities and Regions, it was decided to select three case studies from Central, Southern and Eastern Europe. While this provided an approximate range of case study Cities and Regions, this presented significant challenges in terms of language barriers as previously discussed in Section 3.2.2. While the research team sought to mitigate this through six-weeks of stakeholder engagement this was not always possible as in the case of Prague. As such, it is recommended that future assessments include a longer lead-in time for stakeholder engagement and that research teams seek to take full advantage of stakeholder networks, such as the Circular Cities and Regions Initiative and the Circular Economy group of Cities and Regions in the European Stakeholders Platform.

3.4 CONCLUSIONS AND RECOMMENDATIONS

> **It is recommended that this indicator is considered for further development, with significant work required to facilitate its progress.**

Following analysis of desk-based research and stakeholder engagement, it is apparent that this indicator is suitable for further development across the EU. This directly feeds into the objectives of the CEAP and Just Transition which seeks to facilitate inclusive, sustainable growth through the development of circular business networks and capabilities across Cities and Regions in the EU. Development agencies providing circular economy programmes can be identified through desk-based research and stakeholder engagement, evidence of the programmes verified through a review of the materials they provide, which together provide discrete data points that can be used for future monitoring. At the same time, it is important to acknowledge that other statutorily distinct organisations may also provide similar services and CE programmes. As such future iterations of this indicator should reflect this. In addition, some questions remain regarding the comprehensiveness or comparability of these programmes both within and between regions, and it is recognised that some Cities and Regions will have access to these services through other means (such as municipality-led initiatives or external industry associations). As such, this indicator should be read in combination with other indicators that reflect the uptake or implementation of circular economy activities within each target region.

The findings highlight the different approaches taken by Cities and Regions in the development of circular economy capabilities within their local contexts. In the case of Navarra, a region that is heavily involved in multiple EU projects – including the Association of Cities and Regions for Sustainable Resource Management (ACR+),[21] the European Association of Development Agencies (EURADA),[22] the Circular Economy group of

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[21] Association of Cities and Regions for Sustainable Resource Management, About us. (ACR Plus, 2024). https://www.acrplus.org/en/about-acr/about-us. Accessed: 16/04/2024.

[22] European Association of Development Agencies, Who we are. (EURADA, 2024). https://www.eurada.org/. Accessed: 16/04/2024.

Cities and Regions in the European Stakeholders Platform,[23] and EIT Climate-KIC[24] – the Government of Navarra has taken a proactive approach to address key socio-economic challenges (rural depopulation, brain drain, etc) through a coordinated regional strategy that explicitly seeks to support businesses to transition towards a CE. This has been enabled through the deployment of local action groups and development agencies.

By contrast, the City of Rotterdam, already benefits from a dense network of innovation clusters across the region of South Holland and the Netherlands, which provide access to incubators, research platforms and funding for circular entrepreneurs. This is complemented by Rotterdam Circular, a municipality-led programme to guide the implementation of the city's CE roadmap, and as such are not dependent on development agencies to provide such services (a similar approach is taken by other cities within the Netherlands).[25]

Finally in the case of Prague, as discussed in Section 3.2.1, relatively few development agencies were identified, indicating the relative novel-ness of circularity as an approach and the proactive role of the Municipality in coordinating implementation of the Prague 2030 Circular Economy Roadmap , and in driving uptake of CE programmes within the city.

As indicated above, the research found that limiting the indicator to not-for-profit organisations would have the effect of excluding highly competent private and semi-private entities that are actively seeking to support the development of CE capabilities within the local public and private sectors. These include not-for-profit environmental organisations, start-ups incubators and accelerators, as well as regional CE hubs and training centres. As such, it is recommended that the terminology used to describe this indicator is adjusted to be more inclusive of these stakeholder groups.

In addition, it was found that some organisations and agencies providing these CE programmes within a particular city or region, may actually be located elsewhere. In these cases, these external organisations must be able to provide evidence of continued and substantive CE programmes within that territory, rather than one-off projects. This is to ensure local policymakers have a more accurate understanding of the types of CE support services available in this region.

Within this context, it is recommended that the formulation of the indicator is adjusted accordingly:

- *The number of public and semi-private entities providing regional CE support programmes.*

This should be further supported by technical guidance and best practices regarding the core characteristics of a CE programme, which includes criteria regarding terminology, duration of CE programmes provided, and types of support provided. Not only will this allow reporting stakeholders to better monitor these indicators but will equip Cities and Regions with clear guidance on how they are best able to support local businesses to implement circular practices. As the purpose of this indicator is to provide visibility to organisations explicitly committed to developing local and/or regional CE capabilities among local stakeholders, the type of CE programmes recognised within this indicator may include:
- Awareness and networking activities, such as: professional networking events, industry workshops, and public education campaigns.
- Professional skills development, such as: training courses, professional mentorship, and environmental certification programmes.
- CE business support services, such as: consulting services, business support, technical guidance, innovation and R&D support, financial aid, and corporate and environmental legal advice.

This could be facilitated through the development of a checklist and digital monitoring platform, whereby organisations contacted by municipality/regional government stakeholders can declare the services provided through their CE programmes and upload supporting evidence. The benefit of this approach is that it would

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[23] European Circular Economy Stakeholder Platform, About the platform. (European Circular Economy Stakeholder Platform, 2024). https://circulareconomy.europa.eu/platform/en/about-platform. Accessed: 16/04/2024.

[24] EIT Climate-KIC, About EIT Climate-KIC. (EIT Climate-KIC, 2024). https://www.climate-kic.org/who-we-are/about-eit-climate-kic/. Accessed: 16/04/2024.

[25] Rotterdam Circulair, About Rotterdam Circulair. (Rotterdam Circulair, 2024). https://rotterdamcirculair.nl/en/about-rotterdam-circular/. Accessed: 16/04/2024.

provide visibility to the types of capabilities being developed through their programmes. Nonetheless, this may potentially require significant work as the platform will need to be developed in each official language of the EU and training provided to encourage uptake in each Member State.

Such a checklist may include:

- Assessing the types of CE support programmes available through an organisation's services, their duration and reach (e.g. numbers of individuals, SMEs or businesses supported).

- Refining the criteria for organisational structure to ensure organisations maintain strong ties and support from local authorities, focusing on community-wide benefits.

- An evaluation of how aligned an organisation's efforts are to a city or region's CE strategy and their overall impact on promoting a CE.

A digital monitoring platform to monitor public or semi-private organisations providing CE programmes should seek to capture the following information:

- The number of businesses that have accessed CE business support programmes.

- The number of professionals receiving CE training programmes.

- The amount of financing provided to regional CE initiatives.

- The number or value of R&D support provided to regional CE initiatives.

The success and effectiveness of this platform is entirely dependent on how effectively local administrations are able to engage public or semi-private organisations providing CE programmes and communicate the platform's value.

Type of recommendation	Recommendation	Timeline	Key stakeholders or partners	RACER criteria addressed:
Further stakeholder engagement to refine the parameters of this indicator and enhance its acceptability.	There is a need to consult with relevant stakeholders and Member States to agree clear definitions on what constitutes a development agency, and what other organisations should be considered within this indicator. The EU Commission should consult with these to establish clear criteria regarding the role of public and semi-private organisations promoting CE capability-building programmes to ensure that the services provided are accessible to local stakeholders and support overall regional CE goals.	Medium (1.5-5 years)	Responsible (R): EU Commission Accountable (A): Municipality stakeholder responsible for CE policy development Consulted (C): Regional development agencies C: Member States C: Regional Industry Associations C: CE consultancies Informed (I): Regional Business networks	Relevance Acceptability Credibility
Development of guidance regarding criteria for CE capacity-building programmes	EU Commission to develop clear guidance on the qualities, criteria and components of CE capacity-building programmes that should be provided by development agencies to ensure consistency and comparability between cities and regions.	Short (0.5-1.5 years)	R: EU Commission A: Municipality stakeholder responsible for CE policy development C: Regional development agencies C: Regional Industry Associations C: CE consultancies I: Regional Business networks	Relevance Acceptance Credibility Ease Robustness

Type of recommendation	Recommendation	Timeline	Key stakeholders or partners	RACER criteria addressed:
Development of a regional monitoring platform to track organisations offering CE programmes	Development of a digital platform or tool that will allow public and semi-private organisations that provide CE programmes to register and upload evidence of how their activities are aligned or support a city or region's CE strategy, in order to support regional monitoring efforts. Criteria that should be included are: number of CE businesses supported, number of recipients of CE training, the amount of financing provided to CE initiatives, and value of R&D support provided to regional CE initiatives.	Medium (1.5-5 years)	R: EU Commission A: Municipality stakeholder responsible for CE policy development C: Regional development agencies C: Regional Industry Associations C: CE consultancies I: Regional Business networks	Acceptability Credibility Robustness

4. APPENDICES

4.1 RACER ASSESSMENT MATRIX

Criterion	Description	1 (Poor)	2 (Neutral)	3 (Good)
Relevance	Refers to whether the indicator is closely linked to the objectives to be reached.	Does not support a better understanding of true circularity.	Supports a better understanding of true circularity.	Highly supportive towards gaining a better understanding of true circularity.
		Supports no value-added circular opportunities.	Supports lower value-added opportunities (i.e. metrics related to waste generation, recycling, waste management, etc.)	Supports higher value-added opportunities (i.e. all R-strategies above remanufacturing) and wider systemic change (e.g. indicators that encourage PSS or circular design).
		Not linked to the project objectives and/or European policy objectives (existing or upcoming).	Linked to the project objectives, but not to European policy objectives (existing and/or upcoming).	Fully aligned with project objectives and European policy objectives (existing and/or upcoming).
Acceptance	Refers to whether the indicator is perceived and used by key stakeholders (such as policymakers, civil society, and industry).	Poorly accepted by key stakeholders, e.g. due to the use of confidential data.	Relatively accepted by key stakeholders as the benefits of measuring are clear.	Key stakeholders are motived to report this indicator, due to mandatory legislative requirements (current or upcoming), potential commercial benefit or being in the public interest.
Credibility	Refers to whether the indicator is transparent, trustworthy and easy to interpret.	No defined methodology associated with this indicator and/or interpretation of the indicator is ambiguous.	Methodologies have been proposed or currently existing, but not for this particular indicator (e.g. in a research article).	There is an EU defined methodology.
		Difficult to understand and communicate to stakeholders (e.g. units or measurement of something that stakeholders are not familiar with).	Moderately easy to understand and communicate to stakeholders (e.g. units or measurement of something that stakeholders are aware of but are not confident in practical use).	Easy to understand and communicate to stakeholders (e.g. units or measurement of something that stakeholders already use and are confident in applying).
Ease	Refers to the easiness of measuring and monitoring the indicator.	No defined methodology associated with this indicator and/or interpretation of the indicator is ambiguous.	Methodologies have been proposed or currently existing, but not for this particular indicator (e.g. in a research article).	There is an EU defined methodology.
		Difficult to understand and communicate to stakeholders (e.g. units or measurement of something that stakeholders are not familiar with).	Moderately easy to understand and communicate to stakeholders (e.g. units or measurement of something that stakeholders are aware of but are not confident in practical use).	Easy to understand and communicate to stakeholders (e.g. units or measurement of something that stakeholders already use and are confident in applying).
Robustness	Refers to whether data is biased and comprehensively assesses circularity.	No consistent methodology and dataset are available.	A consistent methodology and dataset available.	A consistent methodology and dataset available.
			A composite/aggregated indicator (based on multiples dimensions).	A one-dimensional indicator.

4.2   CR6 - EXAMPLE OF EMAIL SENT TO STAKEHOLDERS

From: Lee, Ho-Yee <Ho-Yee.Lee@ricardo.com>
Sent: 25 January 2024 13:00
To: marleen.claeys@capture-resources.be <marleen.claeys@capture-resources.be>
Cc: info@capture-resources.be <info@capture-resources.be>; Foss, James <James.Foss@ricardo.com>
Subject: Data request: DG-RTD study on circular indicators

Dear Ms. Claeys,

I hope this email finds you well. My name is Ho-Yee, a consultant within the Sustainability practice at Ricardo. We are currently leading a consortium of partners to develop and test indicators that are fit for use to measure circularity for the **EU Commission's Directorate for Research and Innovation** (DG-RTD).

Due to CAPTURE's work on industrial symbiosis in the Scheldt-Delta region, we would like to ask if the platform would be interested in participating as a case study within the EU DG-RTD study: **Indicators and methods for measuring transition to climate-neutral circularity, its benefits, challenges and trade-offs.**

To do this, we would like to collect data on the following indicator: Reductions in resource use or waste generated annually due to regional industrial symbioses.
This may include:

- Data on quantities of by-products sent for valorisation.
- A short 30-minute interview to sense-check data.

Would you be interested in discussing this further with us? Or alternatively, are you able to pass this request onto any team members or partners who would be?

How will participating benefit your platform?
The data and insights you provide will be analysed to understand how feasible and practical these indicators are to measure circularity across the EU.

By participating you will be able to:

- Have your say in how circularity will be measured across the EU, individual Member States and your platform.
- Help to recommend a robust set of indicators that will allow the Scheldt-Delta region to better monitor and improve its circular economy performance.
- Showcase the organisation's engagement in cutting edge CE research that will be presented to EU policymakers.

Please find attached a letter of support from DG-RTD which contains additional background information to the project. Do let me know if you have any questions.

Thank you for your time and assistance,
Ho-Yee Lee
Sustainability Analyst Consultant

4.3   CR6 - INDUSTRIAL SYMBIOSIS SURVEY (ENGLISH VERSION)

Survey questions (English)
What was the total quantity of byproducts your organisation used within the Schelde Delta Region? (Jan 2023 - Dec 2023)   (Please include the appropriate units of measurement.)
Can you provide an approximate breakdown of the byproducts used by your organisation within the Schelde Delta Region by material type? (% or volume)
What is the approximate proximity of the location where the byproducts are used/"valorised" to the source of the byproducts?
Does your organisation have KPI requirements for the use of byproducts in your industrial symbiosis system?
If yes, please list the KPIs requirements used
What is the value of monitoring data for the indicators discussed in this survey?

Survey questions (English)

What challenges do you currently have, or foresee in the future, in the collection and presentation of the types of data discussed in this survey, and what support do you think would help to address those challenges?

4.4 CR6 - DATA COLLECTION TEMPLATE

See MS Excel document "DGRTD CR6 Total quantity and types of byproducts valorised annually due to regional industrial symbioses systems V1.00" provided alongside this report.

4.5 CR6 - LIST OF STAKEHOLDERS ENGAGED

See MS Excel document "DGRTD_CR6_StakeholderEngagementTracker" provided alongside this report.

4.6   CR10 – DATA COLLECTION TEMPLATE

See MS Excel document "DGRTD CR10 Number of regional development agencies providing circular economy programmes V1.00" provided alongside this report.

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